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Role of Mineral Chelates in Health and Production of Animals

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Introduction

Traditionally, trace elements are supplemented in the diet of the animals as inorganic salts. However, recently there are many reports indicating that absorption and utilization of trace elements is comparatively far better if they are supplemented in the chelated forms related to their inorganic salts. A large number of studies conducted on chelated forms of trace elements indicate that they not only improve the performance of the animals in respect of growth, milk production, wool production or reproduction but they are effective in reducing the various stresses and also improve the immune response of the animals against many infections. The term chelate is derived from a Greek word "chele" which means claw. Chele refers to the claw like structure of the chelate molecule, suggested by the open V-shape of the two ligands on two sides, with the mineral ion in the centre. Various chelates include metal amino acid chelates, metal polysaccharide complexes and yeast derivative complexes *etc.* A number of trace elements in their organic form have been prepared, but only few of them have been studied. This mineral chelates provide better nutrition, grater bioavailability and increased stability of the minerals in the body.

Selenium Chelates

Most common organic form of selenium is seleno-yeast. It is present in yeast as seleno-cysteine and seleno-methionine. Seleno-yeast has been reported to be biologically more active than sodium selenite. In June 2000, selenium yeast was approved by the USFDA as a source of feed supplemented organic selenium for chickens. It improves the antioxidant properties by increasing the glutathione peroxidase (GSH-Px) and tissue selenium concentration in comparison to inorganic sources. Selenium chelates presence in thyroid hormones contributes to maintaining proper thyroid function, influencing metabolism and growth. It was suggested that selenium chelates provides greater protection against free radicals and probably for this reason this is may be used for the treatment of cancer.

Chromium Chelates

Chromium is well established as an essential trace element. Currently it has been found that chromium chelates such as chromium yeast are more bioavailable than chromic salts. Rats receiving chromium chelates outlived the group supplemented with inorganic chromium. Chromium yeast in the diet resulted in decreased cortisol and increased immunoglobulin levels together with faster growth and better feed utilization.

When pigs are supplied with chromium picolinate, cholesterol levels decreased and insulin levels enhanced in the blood (Page, 1991). The positive effects of chromium yeast supplementation on calves are truly remarkable. Research has shown that it can boost their average daily gain and dry matter intake by 27%, while also improving their serum immunoglobulin, cortisol, calcium, and magnesium concentrations (Page, 1991). This proves that using chromium chelates is an effective way to enhance the performance and immune function of stressed calves.

Zinc chelates

Zinc chelates are one of the compounds which have been studied more extensively compared to other minerals. Zinc chelates were far superior in rate of absorption across the gastrointestinal tract and rate of appearance at the target tissue such as hair. Zinc is an essential micronutrient that supports various physiological functions in animals, including growth, immune system function, reproduction, and overall metabolic process. In animal feed, zinc chelates are used to improve the bioavailability of zinc, ensuring that the animals can efficiently absorb and utilize the nutrient. This can lead to benefits such as enhanced growth rates, improved immune responses, and better reproductive performance.

Zinc-methionine is an organic form of zinc that does not contain free divalent cations for chelation with phytic acid in the intestinal lumen. Consequently, it is metabolized in various ways, leading to better zinc absorption. It enhances the growth rate, FCR and skeletal development in poultry birds. Zinc methionine is more effective than zinc oxide in recovery of calves affected with infectious bovine rhinotracheitis (IBR). Animals fed with zinc methionine have more growth rate and higher feed intake. Zinc methionine also improve the carcass grades in the animals. Zinc methionine supplementation prevents foot rot and other hoof problems in feed lot dairy animals. When Ganjam sheep are fed organic zinc @ 20 and 40mg/kg of diet, it enhances the immunity status (Sethy *et al.*, 2018).

Copper chelates

Copper chelates is formed by chelating Cu^{2+} with amino acids, hydrolyzed proteins and short peptides. It can prevent the interaction of copper-phytic acid, copper-vitamins and copper-minerals.

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This process helps protect the copper from undesirable interactions within the gastrointestinal tract, allowing it to be more readily absorbed in the small intestine. The chelated copper complexes can be transported across the intestinal epithelium through specialized transporters, resulting in increased bioavailability compared to inorganic copper sources. The absorptive capacity of copper proteinate is much greater than that of its inorganic salt counterparts. Organic copper enhances intestinal microbial population in livestock and poultry and reduced copper excretion of finishing pigs as compared to inorganic copper (Boland *et al.*, 1996). Chelated copper promotes optimal growth by supporting enzyme systems involved in energy metabolism, tissue development and collagen synthesis. As copper is a cofactor for enzymes involved in collagen and elastin synthesis, it is important for maintaining healthy skin, bones and blood vessels. Chelated copper supplementation may enhance an animal's ability to counteract oxidative damage in cells.

Manganese Chelates

Manganese chelates plays a crucial role in animal health and production. It is an essential micronutrient that supports various biological processes, including bone formation, enzyme activation and immune function. It is commonly used in livestock and poultry feed to promote healthier skeletal development and to enhance the efficiency of energy utilization. It was found that Organic Mn sources have more positive effect on performance and egg shell quality of laying hens than its inorganic form. Role of chelated Mn in animal nutrition is yet not well studied and more work is needed to be carried out in this aspect.

Conclusion

Now there is a good amount of information available from many countries and there appear to be a consensus that chelated minerals have by and large positive and beneficial effects, particularly in respect of immune response and stress conditions of the animals. The feed industry is now looking forward to the second-generation chelated minerals involving selected amino acids or peptides to suit the targeted tissues based upon growth response and stimulation of the immune response.

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